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On Evolution Trend of R&D Input and Scientific and Technical Input in Jiangsu Province

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***Abstract*—The important role of scientific and technical input for enhance initiative innovation ability and strengthen competitive capacity is discussed. The changing trends and characteristics of scientific and technical input in developed countries are analyzed. The present situation of scientific and technical input in Jiangsu Province is analyzed by compared with other provinces and based on practical data. And the channels and countermeasures to increasing scientific and technical input is put forward.**

***Keywords*—Evolution trend of R&D input, Scientific and technical input, Initiative innovation ability,Jiangsu Province**

I. INTRODUCTION

The scientific and technical input has become the most important strategic input Since the second half of the 20th century, various countries, particularly developed countries, have taken advancing technology and innovation as a national strategy, greatly enhancing the scientific and technical input and speeding up the development of science and technology. Taken America as an example, from 1953 to 2001, its GDP grew 27.4 times and the corresponding R&D input grew 55.7 times. In 2008, the proportion of the R&D input to GDP of America is about 2.62%. The US government emphasizes basic researches, the strategic high-tech and its industry, and the application of scientific and technological achievements in production, and that provides a durable power for American economy and society as well as the initiative in the international competition of science and technology, and economy.

With the development of technological and economic globalization, innovation capabilities have become the determining factor of national core competitiveness. Various countries take technological innovation as a primary way to strengthen national competitive power comprehensively, and regard the scientific and technical input as the most important strategic input. It has become the political concept of many countries that the input on science is to invest on the future of a nation. Since the beginning of the 21st century, many countries carry out the strategic policy of prioritizing the scientific and technical input one after another. While dramatically increasing the input of state finance on R&D, it is clearly proposed that increasing the R&D input proportion to GDP is the public policy target of the government.

On the condition that competition in science and technology has gradually become the focus of national competition, the total input on R & D around the world increases rapidly. Not only are the developed countries, many developing countries also attaches great importance to scientific and technological input. In 2004, the world's total R & D input reached 680 billion U.S. dollars. In 2008, the total R & D input of top 12 countries reached 806 billion U.S. dollars. The average inputs of international R & D input has reached around 1.6%of GDP, and in developed countries the amount of R & D input is over 2% of GDP (See in Figure 1).

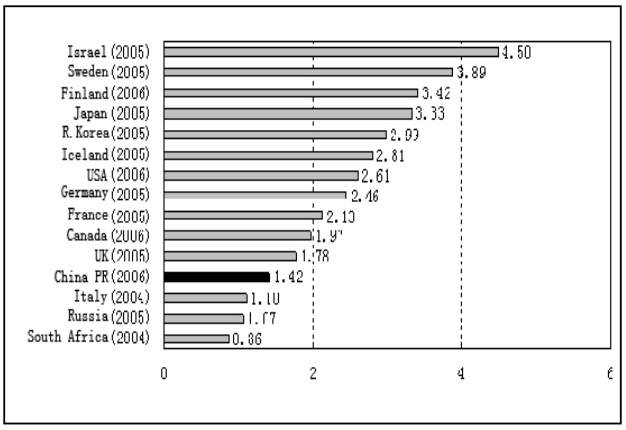

Figure 1. Ratio of R&D total budget to GDP

As one kind of strategic input, the scientific and technical input plays an irreplaceable role in speeding up the construction of region innovation, advancing innovation capabilities of regional science and technology, and realizing the stable and continuous development of regional science and technology, economy and society. Especially for provincial regions of China, both the area of jurisdiction and the population in some region are the same as medium countries. In order to develop sustainably, the technological input must be increased and the main innovation capabilities should be constantly strengthened.

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II. THE EVOLUTION TRENDS AND CHARACTERISTICS OF SCIENTIFIC AND TECHNICAL INPUT IN DEVELOPED COUNTRIES

A. The Evolution Trends of Scientific and Technical Input in Developed Countries

According to Dai Zhenhai and Zhou Jizhong's research, in the US, Japan, Germany, South Korea and other developed countries, as time goes by, the change rule of the proportion of the R&D input to GDP is an S curve. According to the change of the proportion of the R&D input to GDP, the growth process can be divided into three stages (see Figure 2).

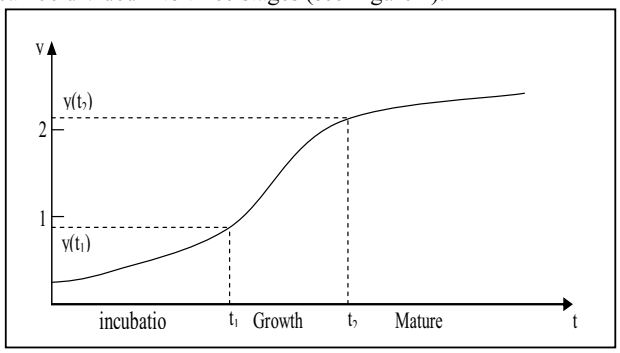

Figure 2. Division of R&D investment stages in developed countries

The first stage is the incubation period that the proportion of the R&D input to GDP increases gradually; the second stage is the growth period that the proportion of the R&D input to GDP increases rapidly; and the third stage is the maturation period of that the proportion of the R&D input to GDP stays between 2% and 3%. Among them the first turning point is namely the one divides the first stage and two $y(t_1) \in$ [0.7 %,1 %] while the second turning point is the demarcation point that divides the second and the third stage $y(t_2) \in$ [2 %,2.2 %].

In the process of the R&D input growth in the US, Japan, German and Korea, the division of the periods of incubation, growth and maturation is shown in Table I. As Table I shown, the incubation periods of those countries are different. However, their growth periods are all between 10 to 20 years and the economy in those countries grows rapidly during those years. Stepping into the 21st century, the scientific and technical input is in a new round of growth.

TABLE I. R&D/ GDP GROWTH STAGES IN THE US, JAPAN, GERMANY, AND S.KOREA

Stage division	incubation period	growth period	Mature period
The U.S	1930-1950	Early 1950s-early 1960s	started in mid 1960s
Japan	1950-1960	Early 1960s-early 1980s	started in early 1980s
Germany	1946-1955	Mid 1950s-mid 1970s	started in late 1970s
S.Korea	1955-1980	Early 1980s-mid 1990s	started in mid 1990s

B. Characteristics of the Scientific and Technical Input in Developed Countries

The evolution of the scientific and technical input in developed countries is characterized as follows.

First, the growth period and rapid economic development are synchronized. The beginning of the growth period generally occurs when GDP per capita is more than 1000 U.S. dollars, and that is also the beginning of rapid economic growth. As a rapid economic growth needs the scientific and technical input increase substantially, the R & D input increases rapidly.

Second, the growth period lasts 10 to 20 years. After the incubation period, the proportion of the R&D input increases from 1% to 2% rapidly. For example, the US did it in 10 years; Korea took over a decade to make it while Japan and German made it in two decades.

Third, with the growth of scientific and technical input, the R&D inputs that governments invest in are gradually reduced. In the incubation period, the government input is primary, while the enterprise input on the R&D is not much. In the growth period, the government input and the folk input on the R&D are 50% respectively .In the maturation period, the enterprises gradually become main investors of the science and technology.

Fourth, it is emphasized that the government input in R&D is to realize the national objective. From the 1990s, various countries stressed more that the government R&D input should aim at realizing the national objective and emphasize the investment in technology and public infrastructure as well as to support national strategic industries. The key input generally including researches on preliminary content, strategic hi-tech, techniques about public welfare, the basic facility construction of science and technology and the R & D of strategic industries.

Fifth, a new round of investment in science and technology is growing rapidly. At the beginning of the 21st century, the United States, Europe and some newly industrialized countries began to promote a new round of growth of the scientific and technical input. In 2005, The federal budget of R&D of the United States has increased to 132 billion dollars. In 2008, it reached 343.7 billion dollars. In 2002, the EU passed Plans about making R & D funding accounted for 3% of GDP in Barcelona, explicitly calling on its member countries to increase R & D input to 3% of GDP by 2010. In 2005, the R & D input of Korea was 23.587 billion dollars, 2.99 percent of GDP, and Korean government planed to double the input. President Lee Myung-bak pledged to increase the input proportion of GDP to 5% by 2012. Also he pledged to make Korea to be "world's seventh largest country in the field of brain research" in the coming ten years.

III. ANALYSIS ON PRESENT SITUATION OF THE SCIENTIFIC AND TECHNICAL INPUT IN JIANGSU

In recent years, the total input in science and technology keeps growing in Jiangsu Province, as well as the R&D input. However, there are problems such as the inadequate investment of the government, unbalanced regional development, and low investment in science and technology of small and medium-

sized enterprises. An Effective integration of science and technology investment and a steady growth mechanism have not yet formed, and thus the scientific and technical input can not catch up with the economic and social development. In order to find out strengths and weaknesses, there is a table of relevant data from six developed provinces and cities as a comparison.

In 2006, the R&D input of Jiangsu amounted to 34.61 billion Yuan, which was lower than Beijing (43.3 billion Yuan). It ranked second around China, and was slightly higher than the third, Guangdong (31.3 billion Yuan). The proportion of the R&D input of Jiangsu to GDP is 1.6%, slightly higher than the national average level (1.42%), and lower than Beijing (5.5%), Shanghai (2.5%), Tianjin (2.18%), and it ranked fourth (See Table II). According to the division of periods, Jiangsu has entered the growth period, which is also known as a period of rapid growth. The proportion of R&D input to GDP will be hopefully over 2% around 2010, and that is the maturation period.

TABLE II. RANKINGS AND AMOUNT OF R&D INPUT IN 8 CITIES AND PROVINCES IN 2006

Provinces& Cities	Jiangsu	Beijing	Shanghai	Tianjin	Guangdong	Zhejiang
R&D	346.1	433	258.8	95.2	313	224
Ranking	2	1	4	8	3	6
R&D/GDP(%)	1.6	5.5	2.5	2.18	1.19	1.42
Ranking	4	1	2	3	7	6

Table II is about the scientific and technical inputs and their rank of six provinces in 2006. It is shown that in 2006 the Jiangsu local finance input in science and technology was 5.44 billion Yuan, ranked fifth, which was lower than Guangdong (10.41 billion Yuan), Shanghai (9.44 billion Yuan), Zhejiang (6.29 billion Yuan), Beijing (6.05 billion Yuan), and it was only 52% of Guangdong. The proportion of Jiangsu local finance input in science and technology was 2.7% of total local expenditure. It ranked at the end of the six provinces or cities, lower than the national average 4.2%. The government insufficient input has become the bottleneck of turning Jiangsu into an innovative province.

TABLE III. PROPORTION OF LOCAL SCI-TECH INPUT TO THEIR LOCAL FINANCIAL EXPENDITURE IN 6 PROVINCES AND CITIES

Provinces& Cities	Jiangsu	Beijing	Shanghai	Tianjin	Guangdong	Zhejiang
Sci-tech input	54.4	60.5	94.9	18.3	104.1	62.9
Ranking	5	4	2	8	1	3
Proportion of input (%)	2.70	4.66	5.23	2.79	4.08	4.29
Ranking	6	2	1	5	4	3

According to statistics of national and local advancement in technology from the national technical department in 2007, Jiangsu was not good (See Table IV) in the environment, input, and production of technology development, motive force of science and technology on social advancement and other important aspects, and it ranked at the end of the six provinces or cities. As an economical big province and technical big province's status, Jiangsu could have done more.

TABLE IV. SCI-TECH INDICES AND RANKINGS OF 8 CITIES AND PROVINCES IN 2007

Provinces& Cities	Jiangsu	Beijing	Shanghai	Tianjin	Guangdong	Zhejiang
Index of environment in technology development	54.64	85.78	78.92	74.74	52.04	55.69
Ranking	6	1	2	3	7	5
Index of technology activity input	59.53	68.41	77.24	65.19	60.55	61.68
Ranking	6	2	1	3	5	4
Index of technology activity output	32.98	91.53	84.39	63.72	38.16	27.96
Ranking	6	1	2	3	5	8
Index of development promoted by technology	62.72	77.34	81.91	80.08	76.78	66.42
Ranking	6	3	1	2	4	5

Besides, many enterprises in Jiangsu do not take the R&D input seriously. Except for large scale enterprises and hi-tech enterprises, which increase their input continuously, the scientific and technical inputs of small and medium-sized enterprises are somewhat less. It is inevitably that enterprises' insufficient R&D inputs certainly have a negative influence on enterprise technological innovation seriously.

IV. CONCLUDING REMARKS

Jiangsu is in the growth period of R&D development with the expanding in financial scientific and technical input by government. In the guidance of the government, the R&D of enterprise will be in growth, passing the transition period of the R&D investment from the growth period to the mature period time.

While increasing government scientific and technical input, the reform of finance science and technology funds' administrative mode and operational mode should be taken into practice to realize the technical funds management pattern scientific style and the marketability in operational mode.

Policies on R&D input should be taken into practice to gradually set up the dominating position of enterprise in the scientific and technical input by enhancing the enterprise investment on science and technology, the innovative product and building enthusiasm in establishing brand and applying for property rights.

Finally, via support from policies and exclusive funds, it is imperative to encourage research institutes and colleges building up the sense of property rights and putting emphasis on construction of intermediary service system in order to intensify the protection of property rights and encourage the original innovation in Jiangsu.

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REFERENCES

[1] Zhenhai Dai, Jizhong Zhou,Fan Zhang. Theory of the first input. Beijing:Science and Technology Literature Publishing House,1993

[2] Yongyi Qu. Current Status and Countermeasures of Technology Input in Shandong.Shandong Social Science,2005,10:88-91

[3] Chaofu Xu, Wendong Lv. Features and Inspiration of Technology Input in Developed Countries.Journal of Changsha Railway University,2005,6(4):74-75

[4] Sifeng Liu. Mathematical Models on evaluation Indicators of Comprehensive Technology Potential. Journal of Nanjing University of Aeronautics and Astronautics,2002,32(5):409-412

[5] Xiangxiao Zeng. The Inspiration on Trend in Technology Input in Developed Countries. Science and Technology Management Research,2003,5:111-112

[6] Hengchao Sheng. Some Suggestions on Governmental Support on Technical Innovation Overseas.Technology and Industry Across the Strait,2006,2:8-12

[7] Panels in Technology Department .Surge in technology Input Worldwide.China Venture Capital,2006,3:24-25

[8] Yali He. Multiple Efforts on Technology Input. China Venture Capital,2006,2:34-36

[9] Sifeng Liu, Jie Li. Analysis on Efficiency of Usage and Structure of Technology Budget. Sci &Tech and Economy,2005,18(1):26-28

[10] Chuanmin Mi,Sifeng Liu,Ju Yang. Study on Gray Correlation of technology Input and Economy Development .Science of Science and Management,2004,25(1):34-36

[11] Hai Wang,Yuanxu Ye. Analysis on scientific and technical input in China. Research and Development Management, 1999, 11(1): 9-12

[12] Fumin Zhao,Sheng'an Su, Shan'gang Zou. Analysis on the Impacts of S&T Investment of Chinese Government to that of Large and Medium-sized Industrial Enterprises. Research and Development Management, 2006,18(2):78-84

[13] Liu Sifeng Dang Yaoguo. Technical Change and the Funds for Science and Technology. Kybernetes: The International Journal of Systems & Cybernetics.2004,33(2):295-302

[14] Sifeng Liu, Bingjun Li and Yaoguo Dang. The G-C-D Model and Technical Advance. Kybernetes: The International Journal of Systems & Cybernetics.2004,33(2):303-309